Journal of Physical Science and Innovation
Volume 13, No. 1, 2021
ISSN: 2277-0119
http://www.cenresinjournals.com

EFFECTIVE DESIGN STRATEGY TO ENHANCE THE NEED OF NATURAL LIGHTENING AND VENTILATION IN A CULTURAL FACILITY

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ABSTRACT

The incorporation of culture into developmental policies and projects of rural-urban dwellers isapt at this period in our history as this offers various advantages. Culture is the be all and end all of development (Senghor, 2001) and as such the successful design of a Proposed Delta state cultural centre will satisfy the quest to achieve development. Design strategies that encourage community participation needs to be meticulously explored and employed; a deviation from this will result into a failed approach at taping into the wealth of benefits culture provides. This journal therefore seeks to highlight architectural ways of resolving the issue of ventilation and lighting by adhering to natural principles that will give functional and enhanced design actualization. This study uses analytical approach of research into past innovations; its successes and failures and by extension propose workable solutions.

Keywords: Culture, Development, Strategies, Design, Participation.

INTRODUCTION

Culture comprise of all the unique beliefs and attitudes which give shape to life style, identity, arts and intellectual achievements of a group of people or community (UNESCO 2009). Cultural identity is one's own sense of his culture, it is also defined as the influence one gains by belonging to a certain culture or group (Smith 1991). Kwara State was created in May 1967, as one of the first of 12 states to replace the nation's four regions. Originally the state was known as West Central State but the name was later changed to Kwara, which is a local name for the Niger River. The size of the state has been reduced over the years, as new states have been created within the federation. The total landmass of Kwara State today is around 32 500 square kilometres.

Natural Ventilation Principles

Hybrid ventilated buildings are difficult to compare. Air supplies or exhausts may be centralized or decentralized. Apart from the chosen system there is a varied use of natural forces, like buoyancy, wind and sun. The most important different types of ventilation are:

1) decentralized supply and central exhaust,
2) Central supply and decentralized exhaust and
3) Central supply and central exhaust. Additionally, there are all kinds of combinations possible with mechanical ventilation and cooling. Moreover, the way of local ventilation may vary as well, with mixing or displacement ventilation as the most obvious differences. When displacement ventilation is applied it will always be necessary to warm the air to near room-temperature. In the long run economical and practical issues will determine as well which system will be applied. Physical principles General Buoyancy or the stack-effect is the most important driving force of natural ventilation being to a large extend sufficient to ventilate a building. Interesting is the self regulating effect of buoyancy: the higher the heat load of the building, the larger will be the air flow and cooling effect of natural supplied and exhausted air. Recently several buildings have been designed that make use of this principle but even those buildings make use of positive wind-pressures in the inlet-plenum. In a hot and moderate climate extra heating of the chimney or cooling is necessary during some periods of the year. (Lomas, 2007),

However, for a moderate climate with a modest internal and external heat load the use of other natural forces like sun and wind may be required as well in order to create higher pressure differences in certain periods of the year. For instance, when the desired low indoor temperatures in summer are achieved, the stack-effect will be reduced. Buildings with natural air supply via the façade can suffer from high negative pressures on the façade, which differ from systems with natural air supply via a central atrium. Heat recovery in the exhaust may be required in order to minimize heating and cooling energy, but this depends on effectiveness of the airflow-control strategy as well.

Buoyancy Buildings that are ventilated via atria and shafts have more options to use wind-pressure in a positive way. Buoyancy is effective when the inside temperature is higher than the outside temperature. Cool outdoor air with a higher density will replace hotter air with a lower density. In principle, internal heat sources are sufficient to ventilate a building. However, in the cooling season with lower pressure differences, there is in an increased risk of a return flow of air. Buoyancy can be increased by the height of a shaft, the temperature in the shaft or a lower pressure in the shaft due to wind. Another option is a building-design where return-flows are just another way of ventilation. Wind Wind is almost always available, but an effective usage is often misunderstood. Coastal areas have more wind. The wind-pressure depends on the height of the building related to the surrounding buildings. The under-pressure is generally the lowest above the roof of a building. This can be increased by the shape of building and exhausts. Options are a venturi-shaped outlet or a cowl-system (Khan, 2008, Blocken, 2011).

The under pressure above a roof should always be lower than the pressure on the inlets. Sun High outdoor temperatures go always together with much sunshine. In periods with a low buoyancy force, the sun can overtake the role of buoyancy and can heat the exhaust-duct or transfers its power to a fan via a PV-system.

Lightening and Ventilation

There's no denying that fresh air is essential to humans - we need it to survive. In an ideal world, we would be constantly outside breathing in clean, pure air. Unfortunately, for many people, this is not the case. It's likely that our jobs and the climate that we live in can determine that we will be spending a lot of our time indoors – which, in turn, provokes the need for a good ventilation system.

Ventilation refers to the process by which 'clean' (normally outdoor) air is intentionally supplied to a space, while stale air is removed. There are various types of ventilation systems that can be used – such as air conditioning (including fan coils), air curtains, air recirculation and air infiltration. Ventilation is especially required for commercial and industrial spaces to control indoor air quality by diluting and displacing indoor pollutants. Ventilation can also be used to control temperature, humidity and air motion. Ventilation is a factors that can't be over emphasis as it is of topmost priority in a situation where high number of people are confined. Find below some importance of this element in this design.

Control Impurities

You may think that the air quality where you live isn't great, especially if you live in a bustling city centre, but in many cases, the air inside can be more polluted than the air outside. A good ventilation system will help expel a build-up of pollutants, bacteria, moisture and unpleasant odours, such as body odour.

Air Regulation

Unless you have a good ventilation system in place, you have no control of the air flow in your building. Too much fresh air can mean costly energy bills, which is why good ventilation helps control the air, while regulating to the required health and safety levels.

Stop Condensation

Condensation can lead to mould and rotten surfaces – which, naturally, is something you would want to avoid. Damp conditions and condensation can also cause health issues, such as allergic reactions and respiratory problems for many people. However, ensuring your company or organisation has good ventilation systems in place will help reduce these risks.

Reduce Temperatures

When there are lots of people in a confined space, whether is for work, conference or a public event, the environment can soon become hot and stuffy. A well-ventilated room will instantly be more comfortable

- creating a more relaxed environment, while also making for a more productive workplace. Blocken, (2011).

Health Benefits:

Another benefit of good ventilation systems is the positive impact it as on health and well-being. Indoor air pollution coupled with bad ventilation can lead to a number of health problems including headaches, allergies, asthma, rashes and sinusitis. However, this can be avoided with the installation of a good ventilation system.

Natural lighting or day Lighting:

These days, exterior lighting now needs to meet codes for a dark sky and light trespass control. This means that any artificial lighting needs to be aimed downward and 'cut off' to avoid lighting adjacent properties. This brings in the popularity of both high-efficiency lighting and natural daylighting to brighten buildings.

Day Lighting

Optimal use of daylight plays a critical role in sustainable building strategies because it's a free, renewable source. Daylighting, shading and lighting control strategies can help to provide a naturally lit and cost-effective building. The most common design sources of natural light include:

- Windows
- Skylights
- Light shafts
- Atriums
- Translucent panels.

The careful architectural design of a building helps maximize natural light while maintaining indoor temperature regulation and light glare reduction. Before including extensive daylighting features in a building, designers orient the structure to maximize daylight potential, taking into account the sun's daily movement. Not only does optimal use of daylighting require zero electricity, but it can also bring to life other important aspects of a building, such as architecture, color, and textures. Occupants of buildings with more daylighting than artificial lighting also tend to see health and attitude and improvements.

Principles of Day lighting/Natural Lighting.

Measurement of Daylight There are two basic types of instruments used to measure light, namely visual and photoelectric meters. Visual instruments of photometry, such as the photometer shown in Figure 7.9, rely on the subjective comparison of two patches of light, one of which can be controlled to match the other. Normally the standard light source and the light source to be measured enter the central chamber of the photometer from opposite directions, illuminating the two surfaces of a central dividing partition. The observer is able to see both of these illuminated surfaces simultaneously through mirrors and adjust the distance of the standard light source from the partition until the two patches of light match in brightness. The use of a photometer is not recommended for building designers who are only from time to time involved in the measurement of light levels. Proper application of this kind of visual instrument requires skill and experience. The difficulties encountered in the design of the required control luminance patch, the constant need for calibration, and individual differences in sensitivity to light of different wavelengths, may lead to unreliable readings in unskilled hands. Photoelectric cells convert light into electricity and therefore measure the current or voltage generated by the incident light radiation. By far the most common choice for both daylight and artificial light measurements is the selenium photoelectric cell or light meter in which incident light is converted directly into electrical energy without the need for an additional, external source of electricity. The selenium cell consists simply of a crystalline selenium plate sandwiched between a metal plate acting as cathode and a metal contact ring anode. This assembly is normally encased in a non-conductive housing and soldered rather than clamped, to avoid damage to the sensitive selenium plate.

Unfortunately, selenium cells tend to drift, due to a decrease in response during the first few minutes of exposure to light.

Over a period of several years (1973-1978) small groups of students were required to undertake a class assignment in which they chose any interior space on campus, measured actual light levels at nine equidistant points within the space at approximately 9 am, 12 noon and 4 pm on successive days, and then compared these measurements with predicted values generated by a computer program. The computer program was capable of calculating two sets of illumination levels at user-specified grid intersection points. One set was based on a Uniform Brightness Sky and the other set was based on the CIE Standard Overcast Sky. Except for spaces with windows facing due west, the calculated values that were based on overcast sky conditions invariably correlated significantly better with the actual measurements than the estimates that were based on uniform clear sky conditions.

Model Analysis: Before the availability of computers, model analysis was a very popular method for exploring the daylight design of buildings. A scale model can be constructed rather inexpensively and fairly quickly out of cardboard. Therefore, even today with the availability of sophisticated computer programs that can render the lighting conditions of building interiors, model analysis is still considered a useful design tool for at least the subjective investigation of the proposed lighting conditions of interior spaces. It has been proven conclusively that the distribution of illumination inside a scale model is identical with that found in a full-size building, provided that the absorption of all surfaces in the model is precisely that of the original building and the luminance of all sources is accurately reproduced. Accordingly, scale models of buildings may be exposed either to the luminance of the outdoor sky or more conveniently to an electrically controlled artificial sky dome. An artificial sky dome of the type shown in Figure 7.11 consists of a reflecting enclosure lit by a series of electric lamps, which may be adjusted to simulate any particular outdoor illumination level. An alternative to the artificial sky dome is a square box lined with flat mirrors, referred to as a mirror box artificial sky. The roof of the mirror sky consists of an opal acrylic sheet illuminated from above by a carefully distributed set of fluorescent lamps. Three principal criteria govern the design of either type of artificial sky: 1. A luminous overhead surface to represent the sky. It is desirable for the luminous distribution of this surface to be adjustable. 2. A ground surface of known reflectance.

The Daylight Factor Concept:
The amount of daylight available outdoors varies hour by hour due to the movement of the sun, and sometimes even minute by minute under intermittent cloud conditions. If, in addition, we take into account that our eyes measure brightness differences and not absolute illumination levels, then it really does not make sense to design the daylight conditions inside a building in terms of specific illumination levels. An alternative and more useful approach is to determine the proportion of the ambient external daylight that should be available at particular locations inside a given building space. These considerations led to the acceptance of the concept of a daylight

The Emergence of Building Science: Historical Roots, Concepts, and Application factor, which expresses the daylight available inside a building as a percentage of the daylight concurrently available out of doors. Specifically, the Daylight Factor assumes that the daylight available from the sky may be measured by the total illumination (EH) received on a horizontal plane from the whole sky. Therefore, the Daylight Factor (DF) is given by: DF = [(indoor illumination at a point) / (external illumination from sky)] x 100 % If EP is the illumination at a point indoors and EH is the simultaneous external illumination from the whole sky, then: DF = 100 [EP / EH] (%)………………………………………………………………. (7.7)

As a guide to the amount of natural light available in the interior spaces of a building, the Daylight Factor has the advantage of relative constancy. Although there may be wide fluctuations in the outdoor illumination level, the ratio of outdoor to indoor illumination will remain constant as long as the distribution of sky luminance remains static. Unfortunately, due to direct sunshine or isolated clouds the distribution of sky luminance will vary in practice. Nevertheless, the Daylight Factor remains a very useful and popular method for investigating:

- The distribution of daylight from area to area within a building.
- The comparison of various window layouts.
- The comparison of the availability of daylight in different buildings.
- The comparison of measurements taken at different times in the same or different building spaces.

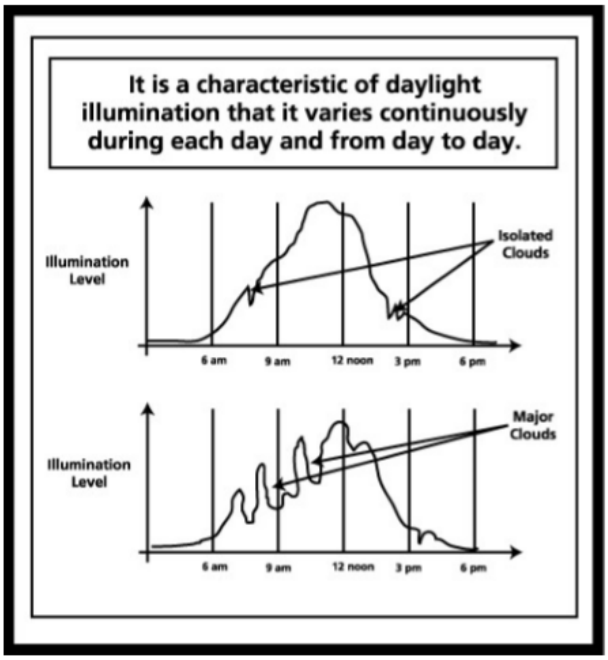

Figure 7.1: Variability of daylight

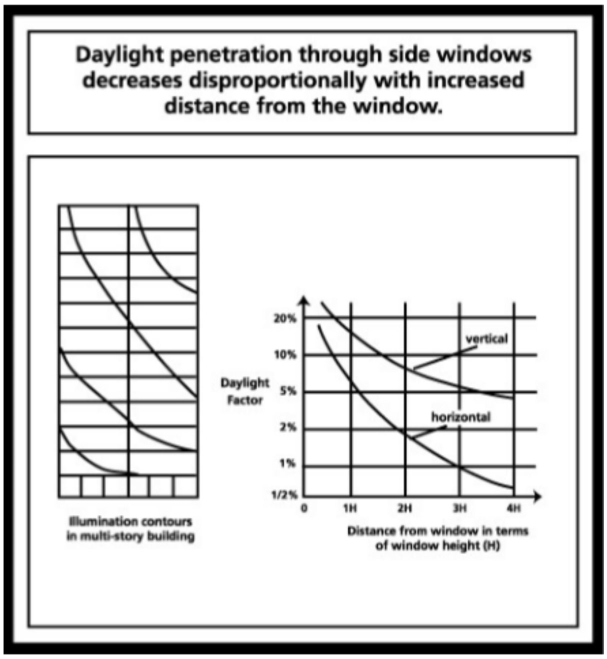

Figure 7.2: Daylight penetration constraints

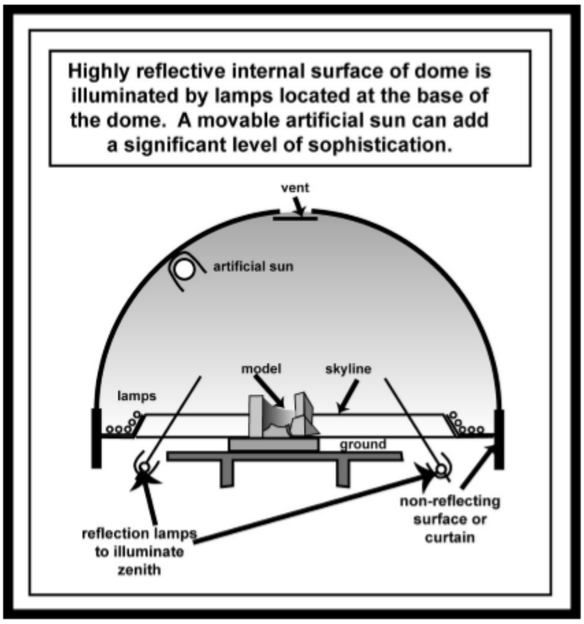

Figure 7.11: Artificial Sky Dome

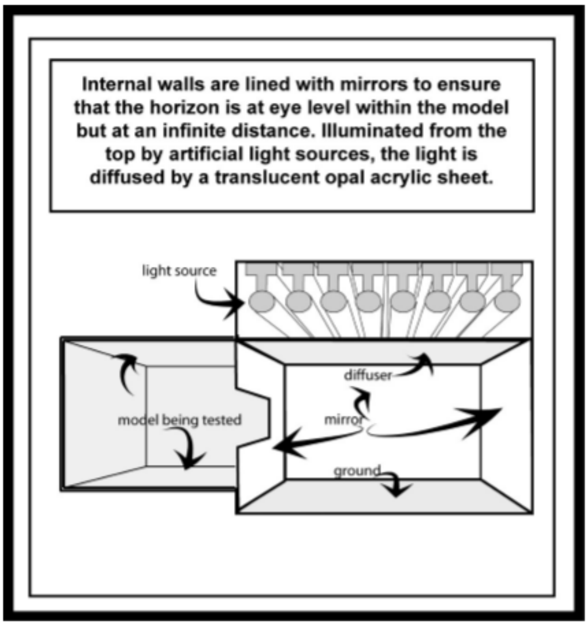

Figure 7.12: Mirror Box Artificial Sky

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Architectural Solutions.

It is pertinent that from the studies above basic architectural solution can be adopted in the resolution of the natural lightening and ventilation. Below are emphasized architectural element which when carefully and conceptually adopted can give solution this subject matter.

- Windows
- Skylights
- Light shafts
- Atriums
- Translucent panels.

The component when well designed according to the principles can enhance natural lightening and ventilation to the spaces where necessary and it benefit can be optimally achieved.

CONCLUSION AND RECOMMENDATION

Building concept goes beyond the building form to the interrelationship between the various facets of the design and as such this should be prioritized at the project design conception and development stages respectively. The careful adoption of principles that guides the placement and design of the highlighted component in other to enhance lighting and ventilation naturally should never over emphasized. It therefore be recommended that this research is carefully studied in other to be enlightened on the way we can mitigate the total use of artificial lightening and encourages the use natural energy for sustenance and efficiency as explained in the study. It also shows that this work is recommended and can be proven for further studies as it highlights the basic principles that guide the design and related facility to ensure that natural element such as daylight and air is optimally of importance.

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